COMPSCI 314 S2 C   Assignment 2

Department of Computer Science
The University of Auckland
Due Monday 17 September 07, 9:00 am

This assignment will contribute 1/3 of your coursework mark, and 5% to your overall course mark.

Submit your assignment via the DropBox, as a .pdf file.

Answer the following questions

Where the question asks you to *explain* or *comment on* something, your answer should be about one or two sentences long. If you are quoting something, you *must* give a refernce for it. Where you are asked to compute values, you should show your working, i.e. make it clear how you arrived at each answer. Take care with your layout – you may loose marks if your layout is ambiguous or confusing!

Remember that these are *sample* solutions, the markers are expected to use their judgement in assesing your answers.

1. **Stop-and-Wait protocol** [10 marks]
   Assume that you are sending a long sequence of 1500-byte data frames over a 5 Mb/s link from Auckland to Wellington, a distance of 600 km. You may assume that the receiver sends back 64-byte ACK messages, and that signals travel in the link with a velocity of 2×10^8 m/s. Compute

   (a) the time it takes to send a data frame and an ACK frame

   > Time to send data frame = $1500B \div 5 \times 10^6 b/S$
   > $= (1500 \times 8)/(5 \times 10^6) = 2.4ms$
   > Time to send ACK frame = $64B \div 5 \times 10^6 b/S$
   > $= (64 \times 8)/(5 \times 10^6) = 102.4\mu s$

   (b) the transit time for a bit to go from one end of the link to the other

   > Transit time = $600 \times 10^3 m \div 2 \times 10^8 m/s = 3ms$
   > (RTT = 6 ms)

   (c) the link's effective bit rate while transferring a large file

   > Effective bit rate = $1500B$ in $2.4 + 3 + 0.1024 + 3ms$
   > $= (1500 \times 8)/8.5024kb/s = 1.411Mb/s$

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(d) the link's percentage utilisation, as a percentage of its specified data rate

> Utilisation (for one $1500B$ packet) = $1.411/5 = 28.22\%$

(e) the time it will take to send a 1 MB file

> We are using a Stop-and-Wait protocol, so
> Time to send 1MB = $(10^6 \times 8)/(1.411 \times 10^6) = 5.67s$

2. **Bandwidth-Delay Product** [10 marks]

(a) What is meant by the term 'Bandwidth-Delay Product,' (BDP) for a network link?

> BDP = data rate $\times$ link delay
> = number of bits 'on the wire' for a link

(b) What effect on the performance of a given link would you expect if its flow control uses a window (i.e. buffer) size that is one-half of the link's BDP?

> Assume that a frame's transit time (sender to recevier) is $\gg$ the time to get the frame onto the link,
> and that we send the whole buffer as a sequence of back-to-back frames, using a windowing protocol with window size = buffer size,
> We can send the window in half the transit time,
> but it will take RTT seconds (twice the transit time) before sender gets an ACK for the first frame, so the link can can only run at one quarter of its full speed.

(c) What difference would it make if the buffer size were twice the BDP?

> With this buffer size, ACK for first packet will reach sender at about the same time as the last packet has been sent
> Therefore sender will always be able to run at close to full link rate
> (again providing that no errors occur on the link).

(d) Suggest an effective alogrithm for choosing the buffer size for a link.

> Choose buffer size about twice the link's BDP
> that allows link to always send at full rate.

3. **Handling Packet Collisions** [10 marks]

(a) Briefly describe the Carrier Sense Multiple Access protocol (CSMA)

- Listen to medium for any activity
- If no activity transmit
- Otherwise (medium is in use), wait

(b) How does CSMA differ from the earlier 'pure Aloha' protocol?

Aloha didn't check that the medium was not in use, 'any host can broadcast a message at any time'

(c) What changes are needed to add Collision Detection to the CSMA protocol?

- Watch medium for a collision
- When collision detected, stop transmitting,
and send a 'jam' signal so as to stop other transmitting hosts

(d) How does Collision Detection help to make more efficient use of a communications link?

Transmissions stop as soon as a collision is detected, rather than after whole packet has been sent.
That means that less time is watsed by collisions.

4. **Ethernet on Unshielded Twisted Pair links** [10 marks]

(a) Compare the wiring topologies used for 10BaseT Ethernet, and 10Base2

- 10Base2 bus topology, each station uses a tap on the bus to monitor the bus (see whether link is busy, watch for collisions while sending, etc)
The taps are a *passive* way of attaching stations to the bus
- 10BaseT star topology, each station is connected to a hub or switch
Hubs and switches are *active* devices

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(b) List three advantages of using 10BaseT rather than 10Base2, and one possible disadvantage

- Advantages
  - Much easier fault-finding, a fault in UTP link to hub only affects one station (a fault on a 10Base2 bus affects *all* stations on the bus
  - May be able to use existing UTP wiring, no need to run coax cable
  - Installing UTP may provide 'future-proofing,' i.e. higher-speed Ethernet may be able to use exisiting cable (not possible with coax)
  - Can run 10BaseT in Full Duplex mode (not possible with 10Base2)
- Disdvantages
  - Hub or switch ports – being active components - have a cost, passive taps on coax cable are much cheaper
  - UTP max cable lengths are much shorter than coax segment lengths

5. **100Mb/s Ethernet** [10 marks]

(a) Explain how 100BaseTX encodes data as a 4-bit 'nibbles' rather than as a stream of single bits

Take data bit stream, break it into 4-bit nibbles.
For each nibble, look up 5-bit code from a table.

(b) What advantage does 100BaesTX gain by using this encoding scheme?

5-bit codes are constructed so that they don't have long runs of the same bit (0 or 1). That means there are always enough signal transitions for the receiver to recover the clock signal. It also means that the resulting signal has a steady long-term average value (no DC component), which simplifies the receiver electronics.

(c) Why does 100BaseTX use MLT-3 signal encoding, instead of Manchester encoding (as used by 10BaseT)?

> Using 3 signal levels reduces the amount of change in each data bit transition, thereby decreasing the bandwidth needed to carry the signal.
> (Shay says "25% less bandwidth that would be needed by Manchester encoding.")

(d) How does the MLT-3 signal provide information so that a receiver can recover its timing information?

> MLT-3-encoded signals have a repeating sequence of states, somewhat like a sine wave. They therefore have a change in level after each bit (or at most two bits), i.e. they have plenty of level changes which the receiver can use to recover the clock signal.